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Geographic information systems as a strategy for sustainable development in the province of Manabí

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ABSTRACT

Ecuador is committed to venturing into the local development model based on the adequate use of endogenous resources and human potential in the community scenario; but the lack of reliable information associated with the inventory and availability of these resources in the localities does not favor an integrated participation of local actors in the planning and management of social development. The work shows what is related to the design and proposal of a geoportal for sustainable development in the province of Manabi, Ecuador, based on a geographic information system that provides georeferenced data on inventories of indigenous resources and information related to technological variables that can be applied for its use.

The multilayer technical design of the geoweb is exposed, which includes a map server capable of performing the georeferenced data service depending on the user's interest. The concept of development and its evolution up to the present moment is analyzed, exposing the development strategy received by the government in recent years and where an important space is foreseen for the realization of sustainable local development policies. The relevance of geographic information

systems and geoweb is analyzed and some examples related to the proposed geoportal are exposed.

Keywords: Geographic Information Systems (GIS), Geoportal, Local development, Inventory of endogenous resources.

1 INTRODUCTION

The information society is an effective means for the management of territorial resources, as well as a mechanism of transparency and control that society has, for the development of policies focused on sustainable development.

It can be analyzed that currently 1% of the population has what 99% needs, demonstrating the dramatic situation that society faces on a global scale (Stiglitz, 2012). For this reason, it is proposed that in the 21st century the time has come to assume the responsibility of acting from politics, citizens and companies, especially in the local environment, and to do so from other perspectives or thoughts. It is clear that development cooperation means helping to eliminate extreme poverty, but also inequalities in rights and freedoms, ensuring quality of life and a future for all (Calvo, Portet, & Bou, 2014).

The study of innovation processes in new economic spaces characterized by the agglomeration of specialized productive activities and close relations of collaboration and competition between agents of production, trade and services, is an example of the relational shift that has taken place in economic geography since the 1990s (Salon, 2003).

Studies carried out in recent years on the issue of development show that, through the application of traditional models of scientific and technical progress, which focus on developmental solutions and with a centralized vision of planning, it is very difficult to achieve goals related to sustainability, much less the balanced and equitable development of society. There is a need to rethink the usual schemes of development, focusing the vision on the empowerment of local factors and the adequate use of indigenous resources.

Often, however, the image of the territory possessed by the social agents does not exactly correspond to the geographical reality or to the relationships established within it (Rodríguez & Vázquez, 2018).

The paradigm associated with the use of the endogenous resources of each territory can create novel technological alternatives, while at the same time constituting an instrument for the application of policies focused on sustainable development (Vázquez, 2017). This paradigm shift will not be useful if there is not a critical analysis of the economic reality, which allows for the creation of strategic planning articulated with territorial planning, which constitutes a fundamental element in the planning process for sustainable development (Ubilla & Villegas, 2017).

To face the challenge of social sustainability, tools are needed that are capable of making transparent relevant information associated with the availability of endogenous resources from the local level and the different technological variants that allow their optimal use in order to meet the growing needs of society and where resource potentials can be located in a timely manner (Rodríguez & Vázquez, 2018).

A high level of vision is required in decision-making from the physical to the functional, from the administrative to the economic and aimed at sustainable development, taking into account the impacts of technologies on the environment (Arias, González, Herrera, & Pérez, 2015).

The objective of the research is to propose a website based on the policy of the knowledge society, which aims to make available to interested parties and especially to social actors at the local level, relevant information related to the availability of endogenous resources that can be used to promote sustainable development from the local level.

The proposed application will allow interested parties, i.e. undergraduate, master's, doctoral students and project managers, to access relevant data related to endogenous resources for sustainable development in Ecuador, from anywhere in the world, as long as they have a computer and internet access, for the management of sustainable local development projects.

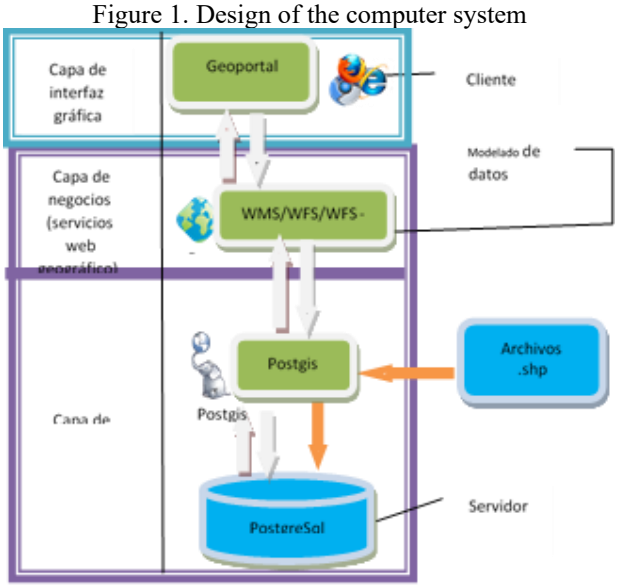
2 ARCHITECTURE

To develop the work, the client-server architecture was used, which is a distributed application model in which tasks are distributed between the providers of resources or services, called servers, and the demanders, called clients. Prado, Extjs, Geoext and Openlayers technologies were also used as a php framework, with the aim of enabling the manipulation of each module of the application. The javascript library called ExtJS version 3.4.0 is used with the aim of improving user interaction, as it offers the ability to provide components with advanced functionalities and easy implementation. It's all about making them easy to use and intuitive.

The server was used as the Geoserver, which is an open-source server written in Java, which allows users to share and edit geospatial data.

The design of databases is obtained from the statistical reports received by the client from the different levels of the territory and from a geographic information system (GIS) the databases that must be used by the users were pre-designed. The design of the geoweb that is proposed is the one currently used by computer systems called multilevel architecture or layered programming. In these architectures, each tier is entrusted with a simple mission, allowing for the design of scalable architectures (which can be easily scaled up as needs increase). The most commonly used design is three-tiered (or three-layered). Figure 1 shows the proposed design.

Figure 1. Design of the computer system



The graphical interface layer or presentation layer is the one that the user sees, it is also called the user layer, it has been elaborated in such a way that it presents the system to the user, communicates the information and captures the information in a minimum of process (it performs a previous filtering to check that there are no formatting errors). It has been made in a friendly way (understandable and easy to use). This layer communicates only with the business layer.

The business layer is where the programs that are executed reside , it is the one that receives the requests from the user and the responses are sent after the process. It's called the business (and even business logic) layer because this is where all the rules that need to be adhered to are set. This layer communicates with the presentation layer, to receive the requests and present the results, and with the data layer, to request the database manager to store or retrieve data from it. Implementation programmes are also considered here.

The data layer is where the data resides, it is responsible for accessing it. It is made up of one or more database managers who carry out all the storage of the databases, receive requests for storage or retrieval of information from the business layer.

For the cartographic information, the information published on the website of regional scale 1:250,000, version January 2013, was used. Layers of basic geographic information from the Institute of Military Geography (IGM) of open access. (UTF-8 encoding) (IGM, 2013).

For the management of the information on the potentials linked to the incident solar radiation and the wind speed, the information corresponding to the databases published on the NASA website was used (Whitlock, 2015).

3 TERRITORIAL DEVELOPMENT STRATEGY

Traditionally, the concept of development is the offspring of the Western notion of progress that emerged in classical Greece and consolidated in Europe since the mid-eighteenth century, when the glimmers of enlightenment began to shine, under the assumption that reason would allow us to discover the general laws that organize and regulate the social order and thus be able to transform it for the benefit of the people (Valcárcel, 2006).

The industrial revolution meant a sharp increase in the demand for raw materials and energy, and it is from that moment on that development is conceived through a linear possibilist thinking, with adherence to technical traditions (Claval, 2000), which has taken the criterion of satisfying human needs and cravings too far, leaving aside the complex social relations that are established between society and the environment, attributing to science miraculous powers with the capacity to solve any problem.

Until the end of the nineteenth century, science had not demonstrated the environmental effects and the accelerated depletion of natural resources that had already accumulated due to the predatory and irresponsible activity of man, therefore, neither ethically nor scientifically there was room for such concerns (Viamonte & authors, 2007).

The extraordinary development of technology and science achieved by humanity in the twentieth century demonstrated the ambivalentity of the creation of the human mind. The sublime and positive have seen the light along with the negative and despicable. A model of development that has led the human species to live in two worlds: one endowed with all possible comforts and the other that faces every day a desperate struggle for survival and against hunger, illiteracy and disease; A first world that has achieved this condition on the basis of the sustained impoverishment of a third world polluted, desertified and impoverished in its natural resources (Viamonte & authors, 2007).

The society of the twenty-first century recognizes that it is very difficult to achieve the articulation of a social progress that is coherent and sustainable, through the practice of a policy anchored in the philosophy outlined by the traditional models of development of capitalism in the mid-eighteenth century. What is needed is a new type of development, one that does not make the same mistakes as past societies, a type of development that prioritizes the Community's priorities according to its own resources, a development that empowers society of its own destiny.

3.1 ECUADOR'S TERRITORIAL DEVELOPMENT STRATEGY

Ecuador's current territorial development strategy provides for the deconcentration of management and services, outlining the development of the different areas of the country, providing for financing of more than nine billion dollars between 2014 and 2017 for the change of the energy matrix, for the diversification of primary sources of energy generation in a better way, Taking into

account that oil, an eventual scenario of depletion of reserves, which are estimated to take approximately no more than 2 decades, is not far away. (Campoverde, Naula, Coronel, & Romero, 2018)

The policy deployed has sought to strengthen the national structure of human settlements, in a polycentric, articulated and complementary manner, in line with the formulation of the National Plan for Good Living, which states the need for public services and development to reach the different territories of the country (Larrea, 2013).

The innovative model proposes to establish development poles in different provinces and close inequality and poverty gaps, for which state investment has been concentrated in public services such as education, health, prevention, social inclusion, internal security, water and sewerage.

The social importance of the strategy consists in the study and search for new models that ensure the sustainability of life, understanding development as an integral phenomenon that encompasses in addition to the economic concept, everything related to the life of society, including intangible cultural heritage, supporting local development. The management of renewable energy sources is proposed as a strategy for sustainable and efficient local development that allows taking advantage of the endogenous resources of the Manabi territory. This can promote local development in the energy field through the use of clean energy sources, which would favor the analysis related to the sustainable diversification of the energy matrix and a greater relocation of sources with the aim of raising the quality and efficiency of the service, thus facilitating the socio-economic development of the territory and achieving greater social equity. (Vázquez, 2022)

Its geographical interest consists in achieving a model of progress coupled with the concepts of territorial development, where it is based on the use of endogenous resources in full harmony with the traditions and cultures of society, in addition to taking into account other factors such as the environmental impact and the risks to which the province is subjected.

The economic importance of the project stems from its very nature, as it is a matter of studying new models of local development, which guarantee a more efficient comprehensive management, where it is possible to minimize the environmental footprint derived from social development and reduce the cost of living for citizens (Larrea, 2013).

4 RELEVANCE OF GEOGRAPHIC INFORMATION SYSTEMS

At the international level, there are various information systems at different levels, global, regional and country, which are linked to the theme of sustainable development for different uses. Its main objective is to provide information to be used based on different applications. (Rodríguez, 2017)

Google Earth is one of the best-known and most widely used information systems in the world, which allows cartographic information to be brought to social agents, scholars and interested parties

(Google, 2012); However, as a weakness it could be pointed out that it does not offer energy information.

The countries of the European Union have drawn up a strategy for the integration of renewable energies in 100 communities, based on the study of the available potential and the appropriate technology, so that they can assess energy systems for local supply in an integrated way. (Sacyr, 2023)

Communities have created local information systems adapted to the specific conditions of each place, the resources available and the type of supply, so that the information is reliable, of quality and that allows the continuity of sustainable energy development (EC, 1997).

An example of the development undertaken by some countries is the project entitled "Geographic Information System for Renewable Energy (GIIS)), which provides a technical analysis of the introduction of renewable energy sources (REFs) into the Spanish electricity generation system (Pinedo, 2007).

The Latin American Energy Organization (OLADE) is developing an adaptable and reliable energy information platform for Latin America and the Caribbean that helps in the effective management and control of energy planning in member countries. It allows comparative analyses and projections of the sector with official and validated information, ideal for decision-making at the national, subregional and regional levels. The system makes the Regional Energy Information System (EIS) available to countries, a fundamental element for the integration of statistical, prospective, legal and documentary information on the Region's energy sector (OLADE, 2018).

The Law for the Use of Renewable Energies and the Financing of the Energy Transition in Mexico (CDHCU, 2013), establishes that it is the responsibility of the Ministry of Energy to prepare and keep updated the National Inventory of Renewable Energies, where the Ministry of Energy instructed the Institute of Electrical Research (IIE) to carry out the work that will lead to the preparation of said inventory and subsequent updates.

In Venezuela, the geographic information system has been used to estimate the potential of solar energy (Posso, González, Guerra, & Gómez, 2014).

5 IMPORTANCE OF A GEOWEB FOR SUSTAINABLE DEVELOPMENT

The integration of geographic information systems into the web environment allows professionals dedicated to developing geospatial information to directly publish query metadata about their services, as well as maps, information and a complex variety of services that users will be able to view, use, combine and enjoy to create applications, meaning more opportunities to share information and take advantage of other services in the interest of development sustainable.

GeoWeb-based systems have ceased to be simple tools for visualization and simple map creation, to become the support for the integration of services based entirely on GIS, which represent

a source of real data, maps, the result of complex models and applications, where users can create new bases to carry out spatial analyses linked to the realization of projects focused on sustainability (Rodríguez, 2012).

There are some experiences based on web initiatives that are supported by geographic information systems, with the aim of promoting the adequate use of endogenous resources, among which we can point out the case of Cuba, where it was verified that the information of the FRE was dispersed in the different sectors and companies of the state. including universities and research centers, corroborating that there was no system that automatically integrated the information, so we worked on different versions of information systems, validated at the municipal level, generalized at the provincial and regional level, managing to develop a version of the GIS for use in rural electrification through the use of renewable energies (Marquez, Rodríguez, Chery, Cisnero, & Morell, 2005).

In order to materialize the idea of grouping and making the information transparent, work was done on the inventory of the FRE and renewable potentials in Cuba, for which the project entitled Geographic Information System of Renewable Energy Sources was articulated, managing to develop a web application through an energy geoportal, which allowed international access to the database of renewable resources throughout the country and offered support of relevant information for carrying out research projects in universities and research centers in the country and abroad. (Rodríguez, Vázquez, Castro, & Heredia, 2011).

5.1 PROPOSAL FOR THE GEOGRAPHIC INFORMATION SYSTEM FOR SUSTAINABLE DEVELOPMENT (GISMS)

Manabí is the third province in terms of population size in Ecuador with 9.6% of the total population of the country, in relation to the surface area it has 6.83% of the national territory which represents the sixth place in size, with a Population density of 75.8 inhabitants per square kilometer (Egas, 2013).

The annual growth rate is 1.65%. The median age of the population is 28.2 years. Illiteracy among people over 15 years of age or older is 10.2% and digital illiteracy among persons over ten years of age is 34.3% (Aster-GDEM, 2014). 63% of its population lives in urban areas, i.e. 862,961 inhabitants, and 37% in rural areas, i.e. 506,819 inhabitants. This relationship is mainly due to the fact that the most populated cantons such as Portoviejo and Manta have 94% and 95% of their population in the urban area respectively, these two cantons represent 55% of the total provincial urban population and when the data related to socioeconomic development are analyzed in these cities, more than 60% of the gross domestic product (GDP) is concentrated (Egas, 2013).

The analysis of the potential of natural and human resources and the socio-economic situation of the Manabite territory allows us to define that there are conditions to assume a decentralized development model, which is based on the use of indigenous resources, shaped by respect for the environment and the achievement of a sustainable development that allows the socioeconomic balance of the territories. with the aim of achieving greater social equity.

But all of the above may be possible to the extent that the conditions can be created that favor the adequate use of the indigenous resources that the territory has, and in this the level of access to relevant information related to the availability of endogenous resources and the technological possibilities of their use in the distributed scheme of local development plays an important role.

Considering the international experiences supported by web pages based on georeferenced information, the Technical University of Manabí began to develop the SIGDS project, which aims to make transparent relevant information related to the availability of endogenous resources in the interest of facilitating the sustainable development of the territory.

To this end, work is being carried out on the SIGDS project, which pursues the objective of creating an open access geoportal with information related to the availability of endogenous resources and the technologies that make their use possible, as well as other data that may be of interest for the sustainable development of localities.

The process seen in a general way begins when a geospatial request is made and sent from the client side to one of the services offered by the server, which is responsible for processing them and resolving the request by carrying out transactions to the database depending on the type of request it is and performs pertinent actions so that the information returned by the database arrives in the appropriate format to the server. customer.

In the business layer (Geographic Web Services) there is the Geoserver tool that works on the server side and provides the geographic services Wms, Wfs, Wfs-T among others.

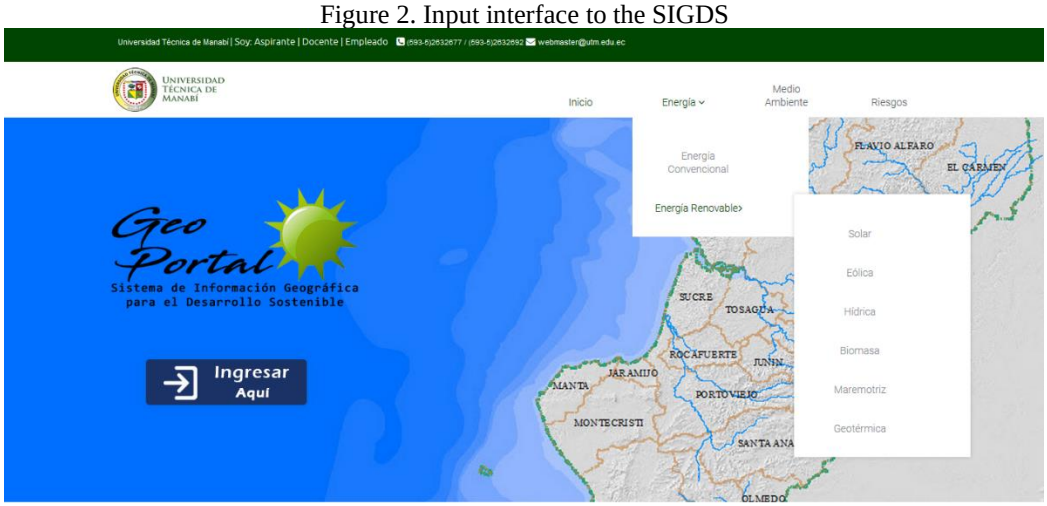
The Geoserver works as an open-source server written in Java, which allows users to share and edit geospatial data. It has been designed from the ground up to operate under interoperability standards. It is able to publish services from the main data sources using open standards (www.zonageo.com.ar). Geoserver version 2.1.2 has been used as a geospatial data server, i.e. a map server and its data, which allows users to query and edit data through the project.

Based on the design of the system and the knowledge of the availability of endogenous resources in the territory, it has been possible to carry out inventories of these, but with the system already designed, the information that will allow the system to be updated can be entered.

The inventories refer to the different alternatives for sustainable development such as renewable resources, main crops, availability of land for agricultural production, as well as the

installation of shrimp farms, the quality of the soil for constructions, etc. Figure 2 shows the input interface to the SIGDS.

Figure 2. Input interface to the SIGDS

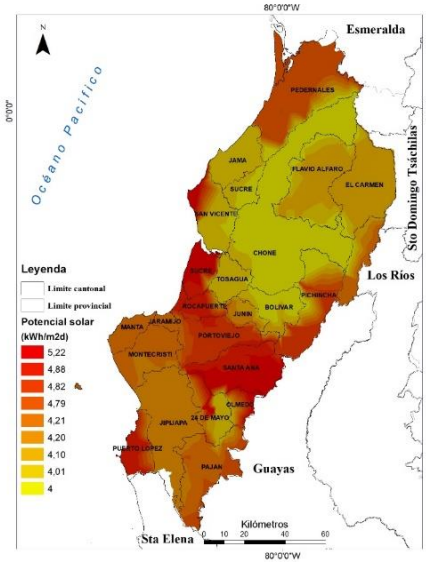


Source: http://geoportal.utm.edu.ec/

The system is capable of deploying an application of the specific types of each of the alternatives related to the availability of endogenous resources. The inventories are distributed throughout the territory of the province, allowing the knowledge of which sites or social and economic objectives are located, being able to make analyses of their location to maintain vitality in special situations or natural disasters.

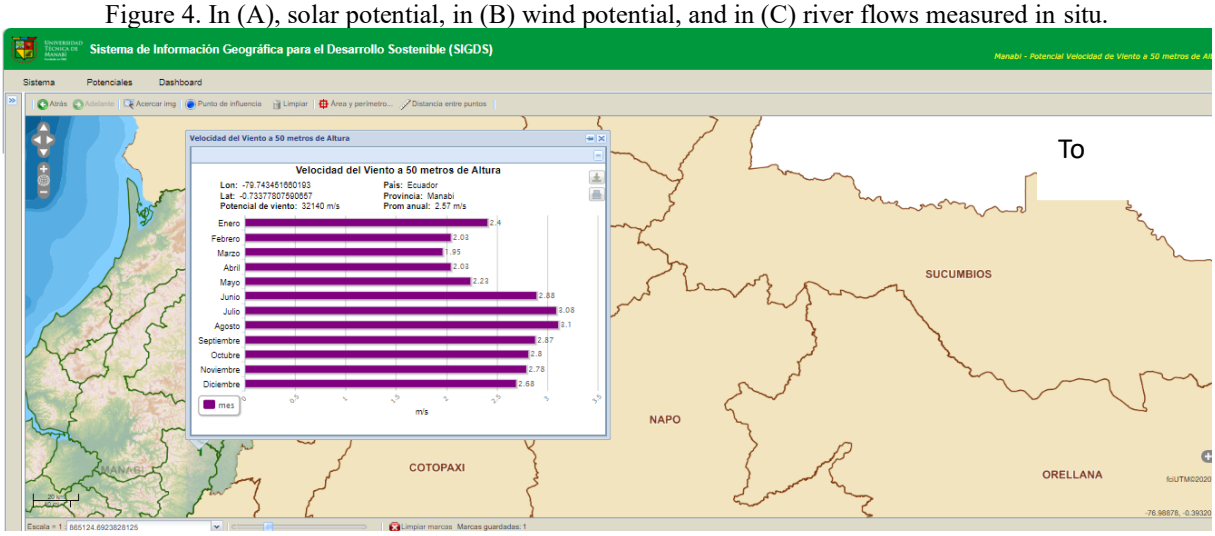
Figure 3 shows the inventory related to the availability of solar potential in the territory of the province, showing that solar radiation affects the length and breadth of the territory that can be used for the generation of clean and cheap energy 365 days a year without interruption, constituting a real alternative for sustainable development through the use of an endogenous resource.

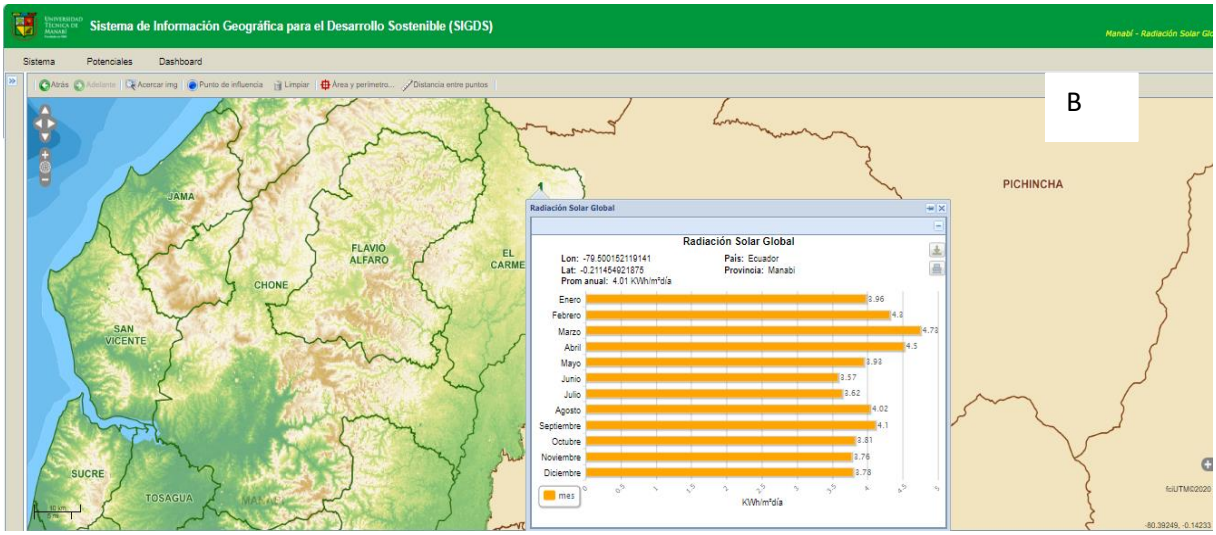
Figure 3. Inventory of solar radiation in the province of Manabí

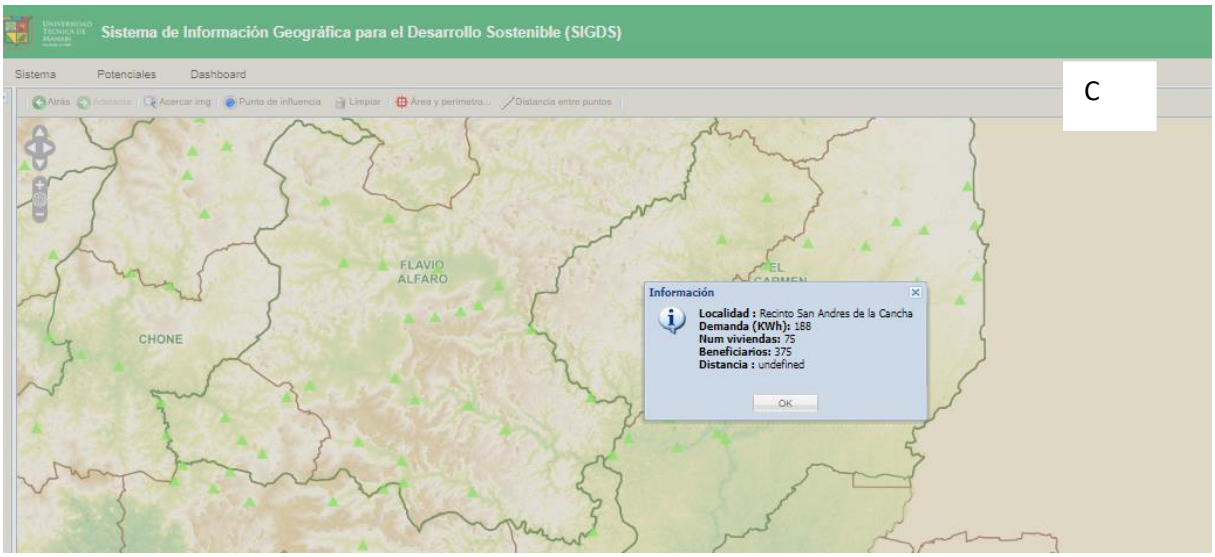


Although there are inventories of solar, wind and water resources, in general, data passes from any site in the province can be obtained in different formats, for example in Figure 4 you can see screenshots of these in specific sites.

Figure 4. In (A), solar potential, in (B) wind potential, and in (C) river flows measured in situ.



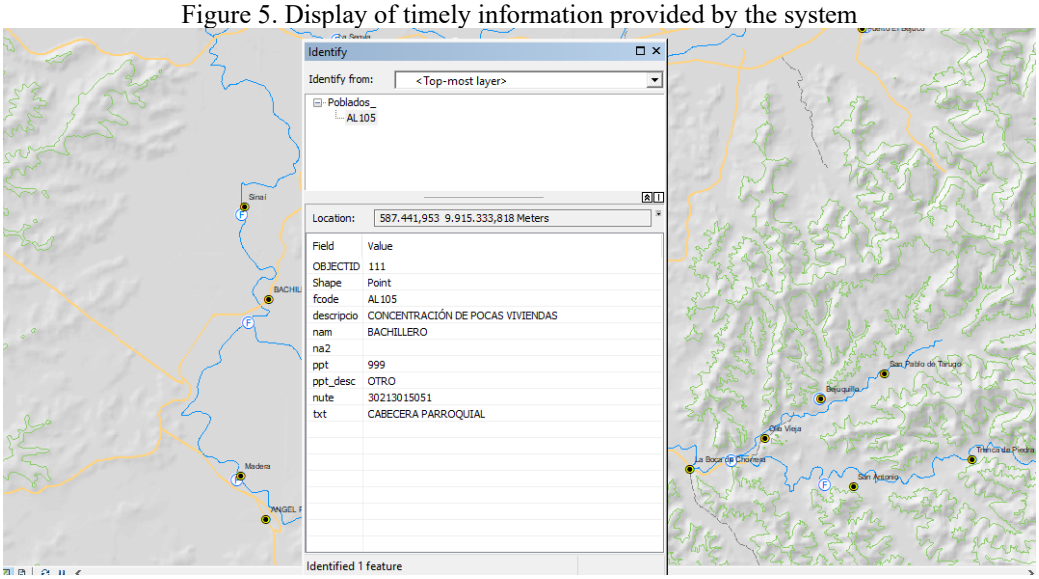




As can be seen, the results can be seen in different formats of each of the potentials already studied at the provincial level, this helps to have a tool for decision-making in the analyses for the diversification of the energy matrix.

The system also offers the potential to provide timely information related to the inventory of endogenous resources. All you have to do is click on the site from which you need to get the data and the required information appears. Figure 5 shows an example of the data provided from the villages in such a way that adequate information is available for demand and potential studies in case there is a need to implement any system that takes advantage of the local renewable resource.

Figure 5. Display of timely information provided by the system



This information is necessary and decisive for researchers who develop local development projects, as it offers data that will allow us to know in the future the number of dwellings and populations in each place studied; in addition to the indigenous renewable potential, being able to direct development to the use and exploitation of these resources aimed at sustainable development.

The data and information contained in the system can be widely used by professors, researchers, students and staff interested in sustainable development alternatives, in order to articulate research projects focused on solving problems at the level of communities and localities.

With the publication of the geoportal (SIGDS) on the web, local actors can achieve a more dynamic role and participation in tasks related to the sustainable development of society so that the Sustainable Development Goals (SDGs) for the country can be met, which proposes: The priority areas for the current programming cycle respond to the transformative vision of the 2030 Agenda towards social sustainability, environmental and economic countries. The innovative measures adopted will revolve around the areas that bring together the SDGs: People, Planet, Prosperity and Peace, and the vision of the National Development Plan 2017-2021 (Lifetime).(ONU, 2023)

6 CONCLUSIONS

With the Geographic Information System (geoportal) that is proposed, it constitutes a user-friendly tool that is easy to manipulate by users, which is based on the principles of the knowledge and information society, with proven potential to promote alternative solutions for sustainable development from the localities; In addition, it can be used for the registration, control and generalization of a diverse field of data, linked to the inventory of endogenous resources of the localities, as well as offering relevant information related to the technological use of these resources, which demonstrates the versatility of the system.

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